Faculty Working Papers

THE INCIDENCE OF THE RESIDENTIAL PROPERTY TAX IN A SYSTEM OF COMMUNITIES: A NEW APPROACH

Jan K. Brueckner, Assistant Professor, Department of Economics

#537

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

FACULTY WORKING PAPERS

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

THE INCIDENCE OF THE RESIDENTIAL PROPERTY TAX IN A SYSTEM OF COMMUNITIES: A NEW APPROACH

Jan K. Brueckner, Assistant Professor, Department of Economics

#537

Summary:

This paper analyses the indicence of the residential property tax in an economy with two communities. Mobility is assumed for workers so that their utility levels are equal in the two communities in equilibrium. The property tax is modelled as an *ad valorem* tax on housing services.

THE INCIDENCE OF THE RESIDENTIAL PROPERTY TAX IN A SYSTEM OF COMMUNITIES: A NEW APPROACH

by

Jan K. Brueckner

I.

In Mieskowski's well-known 1972 paper, modern tax incidence theory, as enunciated by Harberger (1962), was first used to analyse the incidence of the property tax. The paper's unconventional conclusions have now become accepted doctrine, embodying what has been referred to as the "new view" of the property tax.[1] The main idea of the new view is that an increase in the property tax rate in a community has two effects: first, it depresses the rate of return on capital in the economy as a whole; second, it increases the price of capital in the given community relative to its price elsewhere. While Mieskowski's argument was largely informal, a precise analysis of these two effects was presented by Courant (1977).

In spite of the significant improvement in our understanding of the effects of the property tax which the new view has made possible, the public finance literature still lacks an explicit general equilibrium treatment of the tax in a realistic model of the economy, a fact which has been noted by several writers.[2] The present paper begins the task

of filling this void. In addition to developing a complete model of the economy, the paper makes a number of alterations to the new view approach. First, instead of modelling the property tax as a tax on shiftable structure and non-structure capital, it is realistically assumed that the tax is levied on the value of structural services, which are produced with inputs of land and capital. In the residential case, this means the property tax is taken to be an ad valorem tax on housing services. It is well known that an ad valorem tax on the output from a constant returns production process is indistinguishable in comparative static analysis from an ad valorem tax applied at equal rates to the inputs, provided that the comparative static derivatives are evaluated at zero tax rates. Therefore, the residential property tax analyzed in this paper also may be viewed as an ad valorem tax on the land and capital used as inputs in the production of housing. The second alteration to the new view approach is that labor is assumed to be mobile across communities, so that in equilibrium the utility level of workers is the same in each community. The treatment of labor mobility in the new view analysis is unclear, but the assumption of complete mobility is certainly appropriate in any long run model.

The particular model analysed in this paper was chosen after analysis of a number of more attractive models proved inconclusive. The economy represented by the model has two communities occupying equal fixed land areas ℓ (they can be thought of as islands), with the land in each community owned by immobile resident landowners. Workers cultivate part of each community's land to produce an exportable commodity called "wood" with constant returns to scale. The allocation between communities of

the 2L workers in the economy is endogenous. Wood is consumed directly by workers and landowners, but it is also combined with a community's remaining land to produce housing with a constant returns technology. While the utility levels of the mobile workers must be equal in the two communities, landowners' immobility means their utility levels may differ across communities in equilibrium. Comparative static analysis is used to find the effects in the model of an increase in the property tax rate in one or both communities.

A further divergence from the new view approach should be clear from the description of the model: since the capital used in housing production is an intermediate good, the effect of the property tax on the owners of capital, an important concern of the new view analysts, is non-existent in the model. Although this divergence from the new view approach was necessitated by the intractability of realistic models with an exogenous stock of capital, there are reasons for preferring our model in any case. In the real world, capital is not an exogenous endowment of a certain group in the economy, as the new view implicitly requires; it is an intermediate good produced using basic factors such as land and labor. Thus, although our model departs from the new view tradition, it can be argued that its treatment of capital is appropriate for a general equilibrium analysis.

It will help put our model in perspective if the structure of a few of the intractable models which conform more closely to the new view approach is sketched. One model has an exogenous stock of exportable capital in each community owned by immobile individuals. Structures are produced by combining capital with each community's entire

land area. Some structures are consumed directly while the remainder are combined with the community's labor force to produce an exportable consumer good. Since structures are both a final and an intermediate good, the property tax in this model is both a business and a residential tax. In another model, capital is combined with a portion of each community's land to produce housing while the remaining land is combined with the labor force to produce an exportable consumer good. As in the model analysed below, the property tax here is solely a residential tax.

Although results from these models would have told us something about the validity of the new view in a complete model of the economy, the models' intractability required a retreat to our more manageable framework. In spite of its shortcomings, this framework is more realistic than those previously used to analyse the incidence of the property tax. Section II of the paper contains analysis of the model for the general case, where results are incomplete, while Section III presents a complete analysis using Cobb-Douglas utility and production functions. Section IV contains conclusions.

II.

The variables in the model are defined as follows. The wages, land rents, and (gross of tax) housing prices in the two communities are respectively w_i, r_i, p_i, $i=1,2$. The price of wood is set equal to unity. The labor forces in the communities are L_i and the outputs of housing are H_i, $i=1,2$. The land areas used in wood production and housing production

respectively are ℓ_i^K and ℓ_i^H, i=1,2. The wood inputs to housing production are K_i^H, i=1,2, and the property tax rates in the communities are τ_i, i=1,2.

The economy starts in equilibrium with $\tau_1 = \tau_2 = 0$, and the effect of an increase in τ_1 holding τ_2 fixed is analysed. After results for this change are derived, the case where both tax rates increase is considered. Since the land areas of the communities are equal, the initial equilibrium is symmetric, with identical values for each of the variables in both communities. As in the standard Harberger approach, the equilibrium system was totally differentiated, with all changes expressed in relative terms. The resulting labor force constraint and the land constraints in each community may be written

$$dL_1^* + dL_2^* = 0 \tag{1}$$

$$\ell^K d\ell_i^{K*} + \ell^H d\ell_i^{H*} = 0 \qquad i=1,2, \tag{2}$$

where * indicates natural logarithm (that is, $d\ell_i^{K*} = d\ell_i^K/\ell_i^K$, and so on). Note that (1) and (2) incorporate the symmetry assumption because $L_1 = L_2 = L$, $\ell_1^K = \ell_2^K = \ell^K$, and $\ell_1^H = \ell_2^H = \ell^H$.

Housing production is characterized for i=1,2 by the conditions

$$dK_i^{H*} - d\ell_i^{H*} = \sigma^H dr_i^* \tag{3}$$

$$dH_i^* = f_K dK_i^{H*} + f_\ell d\ell_i^{H*} \tag{4}$$

$$dp_i^* = d\tau_i + f_\ell dr_i^* , \tag{5}$$

where σ^H is the elasticity of substitution between wood and land in housing production and f_K and f_ℓ are the factor shares of wood and land in

housing. Each of these quantities is the same in both communities because of the symmetry of the initial equilibrium. Note that (3) embodies the assumption that wood is numeraire and that (5) comes from differentiating the zero profit identity $p_i(1 - \tau_i)H_i - K_i^H - r_i\ell_i^H \equiv 0$ and setting $\tau_i = 0$. Similar conditions for the wood sector are, for i=1,2,

$$dL_i^* - d\ell_i^{K*} = \sigma^K(dr_i^* - dw_i^*) \tag{6}$$

$$g_L dw_i^* + g_\ell dr_i^* = 0, \tag{7}$$

where σ^K is the elasticity of substitution between labor and land in wood production and g_L and g_ℓ are the factor shares. The RHS of (7) is zero because wood is numeraire. A wood-sector equation such as (4) is unnecessary because the changes in wood outputs need not be solved for in the model.

The equal utility requirement for workers means $V(w_1,p_1) = V(w_2,p_2)$, where V is the indirect utility function for workers, who all have the same tastes. Since $\partial V/\partial w = \lambda$, where λ is the marginal utility of income, and $\partial V/\partial p = -\lambda q$, where q is individual housing consumption by workers, differentiating the above equation yields $\lambda(dw_1 - qdp_1) = \lambda(dw_2 - qdp_2)$. Note that housing consumption and the marginal utility of income are the same in both communities by symmetry. Dividing by λ and assuming that all prices are initially equal to one by choice of units yields

$$dw_1^* - qdp_1^* = dw_2^* - qdp_2^* \tag{8}$$

It is important to note that the equal utility condition implicitly ignores benefits from public expenditure; public goods are not among the arguments

of the indirect utility function. This omission follows the Harberger tradition, in which benefits from government spending are never considered. The approach is meant to isolate the pure effects of the tax without introducing issues related to the valuation of public goods.

In the standard Harberger framework, it is assumed that the government spends tax revenue so as to cancel the income effect of any tax change. The validity of this artifice has been discussed by McClure (1975) and Ballentine and Eris (1975). In this paper, however, the demand-shifting effects of the property tax change are incorporated into the analysis. It was felt that in a model where migration of labor can alter the populations of the taxing jurisdictions, the effects of demand changes could not be safely assumed away. To permit demand effects to be included, it was assumed that landowners have the same tastes as workers, and that these tastes generate demand functions which are homogeneous of degree one in income. Furthermore, in keeping with the Harberger tradition, it was assumed that the governments spend their tax revenues in exactly the way they would if they were consumers. These assumptions mean that the demand for housing in each community is given by $D(p_i, w_iL_i + r_i\ell + p_i\tau_iH_i)$, where D is the demand function. Since prices are initially equal to one, the housing demand condition may be written as

$$HdH_i^* = \varepsilon dp_i^* + m[L(dw_i^* + dL_i^*) + \ell dr_i^* + d\tau_i H] \qquad i=1,2, \qquad (9)$$

where $\varepsilon = \partial D/\partial p$ and m is the marginal propensity to consume, which are identical across communities by symmetry. H is the housing output in each community in the initial equilibrium.

The system (1) - (9) contains sixteen equations to solve for the sixteen unknowns dw_i^*, dp_i^*, dr_i^*, dL_i^*, dH_i^*, $d\ell_i^{K*}$, $d\ell_i^{H*}$, and dK_i^{H*}, i=1,2. The changes in wood production in each community resulting from changes in L_i and ℓ_i^K are given by two equations analogous to (4). The wood demand condition, which states that the change in total wood consumption in the two communities equals the change in total wood production, is automatically satisfied by Walras' law.

To solve the system, dH_i^*, dp_i^*, $d\ell_i^{K*}$, dK_i^{H*}, and dw_i^* are eliminated using (4), (5), (2), (3), and (7) respectively. Then dL_i^* is eliminated using (6), and the resulting four-equation system in $d\ell_i^{H*}$ and dr_i^* is solved with $d\tau_2 = 0$. The solution yields

$$\frac{\partial r_1^*}{\partial \tau_1} = \frac{\varepsilon + mH}{2(f_K\sigma^H H - \varepsilon f_\ell - m\ell + \frac{mg_\ell L}{g_L} + \sigma^K H(1 + \frac{g_\ell}{g_L})\frac{\ell_K}{\ell_H})} - \frac{q}{2(qf_\ell + \frac{g_\ell}{g_L})} \qquad (10)$$

From the Slutsky equation, $\varepsilon = \tilde{\varepsilon} - mH$, where $\tilde{\varepsilon}$ is the negative substitution term, and therefore the numerator of the first expression in (10) is negative and equal to $\tilde{\varepsilon}$. Now $g_\ell/g_L = \ell^K/L$ because prices are unity, and similarly $f_\ell = \ell^H/H$. Thus the three middle terms in the denominator of the first expression in (10) are equal to $-\varepsilon\ell^H/H - m\ell + m\ell^K = -\ell^H(m+\varepsilon/H) = -\ell^H\tilde{\varepsilon}/H > 0$. Since the remaining terms in the denominator are positive, the entire denominator is positive and whole expression is negative. Since the second expression in (10) is also negative, we have $\partial r_1^*/\partial\tau_1 < 0$. Equation (7) immediately implies $\partial w_1^*/\partial\tau_1 > 0$.

Since the demand function is homogeneous of degree one in income, the housing consumption of workers, q, is given by w times the ratio of H to

aggregate income. Since w is unity and aggregate income is $L+\ell$ in the initial equilibrium, this means $q = H/(L+\ell)$. Using this result, the second term in (10) becomes $(\frac{2\ell}{H}(1 + \frac{\ell^K}{L}))^{-1}$. Using (5), $dp_1^*/d\tau_1 = 1 + f_\ell dr_1^*/d\tau_1$, and factoring out 1/2 times the positive product of the denominators in (10) gives $dp_1^*/d\tau_1$ the same sign as

$$2\frac{\ell}{H}\ (1 + \frac{\ell^K}{L})[K^H\sigma^H - \frac{\tilde{\varepsilon}\ell^H}{H} + \sigma^K H(1 + \frac{\ell^K}{L})\ \frac{\ell^K}{\ell^H}]$$

$$+ \frac{\ell^H}{H}\ [\frac{\tilde{\varepsilon}\ell}{H}\ (1 + \frac{\ell^K}{L}) - (K^H\sigma^H - \frac{\tilde{\varepsilon}\ell^H}{H} + \sigma^K H(1 + \frac{\ell^K}{L})\ \frac{\ell^K}{\ell^H})]$$

$$= [2\ell(1 + \frac{\ell^K}{L}) - \ell^H][\sigma^K(1 + \frac{\ell^K}{L})\ \frac{\ell^K}{\ell^H} + \frac{\sigma^H K^H}{H}]$$

$$- \frac{\tilde{\varepsilon}\ell^H}{H^2}\ [\ell(1 + \frac{\ell_K}{L}) - \ell^H] \qquad (11)$$

Thus, $dp_1^*/d\tau_1 > 0$ since (11) is clearly positive. In summary, starting from an equilibrium where no property taxes are levied, an increase in the property tax rate in community one depresses land rent but increases the wage and the housing price in that community. All the remaining comparative static derivatives cannot be signed unambiguously, although it may be shown that $\text{sgn}(dL_1^*/d\tau_1) = -\text{sgn}(dr_2^*/d\tau_1)$; labor flows toward (away from) community one when the land rent in community two decreases (increases). It is clear that the landowners' utility level falls in community one since land rent falls while the housing price increases.[3] It may be shown that the utility change for workers is ambiguous.

In order to understand the effects of the property tax rate change in community one, it will be helpful to consider the effects of an equal

tax change in both communities. When both tax rates increase by equal amounts so that $d\tau_1 = d\tau_2 = d\tau$, complete results are easily obtained in the general case. Since the symmetry of the initial equilibrium is preserved, it follows that $\partial L_1^*/\partial\tau = \partial L_2^*/\partial\tau = 0$. Using this fact, it is easily shown that $\partial r_i^*/\partial\tau$, i=1,2, is equal to 2 times the first expression in (10), a negative quantity. This immediately yields $\partial w_i^*/\partial\tau > 0$, and also gives $\partial \ell_i^{H*}/\partial\tau < 0$, $\partial K_i^{H*}/\partial\tau < 0$, which imply $\partial H_i^*/\partial\tau < 0$, i=1,2. Also, the output of wood increases in each community since $\partial \ell_i^{K*}/\partial\tau > 0$ and $\partial L_i^*/\partial\tau = 0$, i=1,2. Finally, it may be shown that $\partial p_i^*/\partial\tau > 0$, i=1,2. Of course, each derivative has the same value in both communities. Thus, when both property tax rates increase, land rents fall and wages and housing prices rise in both communities. Since, land is withdrawn from housing production, wood production in each community increases. Since the wood input to housing falls, housing output decreases and the amount of wood directly consumed increases. Since land rents fall and housing prices increase, the utility level of landowners falls, although the utility change for workers is ambiguous.

It should be noted that the reallocation of land and the lack of change in the labor force in each community make the effect of the tax change on w_i and r_i intuitively transparent. Since land flows from the housing sector to the wood sector, which employs the fixed labor force, it follows that the marginal product of labor and the wage increase, while the marginal product of land in the wood sector, and thus the land rent in both sectors, decreases. This argument cannot be made when only community one's tax rate increases. In that case, the change in land allocation between the sectors and the change in the labor force are ambiguous.

III.

In order to derive complete results for case where community one alone increases its tax rate, this section presents an example using specific functional forms. It is assumed that the wood and housing production functions are $(L_i)^{\beta}(\ell_i^K)^{1-\beta}$ and $(K_i^H)^{\alpha}(\ell_i^H)^{1-\alpha}$ respectively, where $0 < \alpha,\ \beta < 1$, and that the utility function is $h^{\gamma}k^{\delta}$, where h and k are housing and wood consumption respectively. Letting $\theta = \gamma/(\gamma+\delta)$, the equilibrium conditions analogous to (1) - (9) are, for i=1,2,

$$L_1 + L_2 = 2L \tag{12}$$

$$\ell_i^K + \ell_i^H = \ell \tag{13}$$

$$H_i = (K_i^H)^{\alpha}(L_i^H)^{1-\alpha} \tag{14}$$

$$(1-\tau_i)p_i H_i - K_i^H - r_i \ell_i^H = 0 \tag{15}$$

$$\frac{K_i^H}{\ell_i^H} = \frac{\alpha}{1-\alpha} r_i \tag{16}$$

$$K_i = (L_i)^{\beta}(\ell_i^K)^{1-\beta} \tag{17}$$

$$K_i - w_i L_i - r_i \ell_i^K = 0 \tag{18}$$

$$\frac{L_i}{\ell_i^K} = \frac{\beta}{1-\beta}\frac{r_i}{w_i} \tag{19}$$

$$w_1 p_1^{-\theta} = w_2 p_2^{-\theta} \tag{20}$$

$$H_i = \frac{\theta}{p_i}(w_i L_i + r_i \ell + \tau_i p_i H_i) \tag{21}$$

Equations (20) and (21) contain the Cobb-Douglas indirect utility and demand functions respectively, and K_i in (17) denotes wood output in community i. Solving the system (12) - (21) yields

$$r_1 = B(C_1 + C_2(\frac{A_1}{A_2})^{-\theta/t\beta})^{-\beta} \tag{22}$$

$$r_2 = B(C_1(\frac{A_1}{A_2})^{\theta/t\beta} + C_2)^{-\beta} \tag{23}$$

$$p_i = A_i r_i^{1-\alpha} \tag{24}$$

$$w_i = G r_i^{(\beta-1)/\beta} \tag{25}$$

$$\ell_i^H = (1-C_i)\ell \tag{26}$$

$$L_1 = FC_1(C_1 + C_2(\frac{A_1}{A_2})^{-\theta/t\beta})^{-1} , \tag{27}$$

where

$$A_i = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}(1-\tau_i)^{-1} \tag{28}$$

$$C_i = 1 - [\beta + \frac{(1-\beta)(1-\theta\tau_i)}{\theta(1-\alpha)(1-\tau_i)}]^{-1}, \tag{29}$$

$t = \theta(\alpha-1) + (\beta-1)/\beta$, and B, F, and G are constants.

While all the conclusions of Section II may be verified by direct calculation, it turns out that $\partial r_1/\partial\tau_1 < 0$ and $\partial w_1/\partial\tau_1 > 0$ hold regardless of the initial values of τ_1 and τ_2. Since $\partial C_2/\partial\tau_1 = 0$ and it may be shown that $\partial C_1/\partial\tau_1 > 0$, $\partial\ell_1^H/\partial\tau_1 < 0$ and $\partial\ell_2^H/\partial\tau_1 = 0$ from (26). Further calculation shows that when $\tau_1 = \tau_2 = 0$, $\partial r_2/\partial\tau_1 > 0$, which implies $\partial p_2/\partial\tau_1 > 0$ and $\partial w_2/\partial\tau_1 < 0$ using (24) and (25), and the same calculation establishes $\partial L_1/\partial\tau_1 < 0$.

Since labor flows to community two and ℓ_2^H is constant, $\partial K_2/\partial\tau_1 > 0$. Also, the constancy of ℓ_2^H and the increase in r_2 mean $\partial K_2^H/\partial\tau_1 > 0$ from (16), which implies $\partial H_2/\partial\tau_1 > 0$. Furthermore, since $\partial r_1/\partial\tau_1 < 0$, K_1^H/ℓ_1^H must fall from (16). But since $\partial\ell_1^H/\partial\tau_1 < 0$, this requires $\partial K_1^H/\partial\tau_1 < 0$, which implies $\partial H_1/\partial\tau_1 < 0$. Finally, since $\partial L_1/\partial\tau_1 < 0$ and $\partial\ell_1^K/\partial\tau_1 > 0$, it turns out that the sign of $\partial K_1/\partial\tau_1$, is ambiguous. Now since the wage falls and the housing price rises in community two, the utility level of workers there and in community one falls. The utility level of landowners in community one falls, while their utility level in community two, which from the indirect utility function and (24) is proportional to $A_2^{-\theta}r_2^{1-\theta(1-\alpha)}$, rises since $\partial r_2/\partial\tau_1 > 0$.

In summary, when $\tau_1 = \tau_2 = 0$, an increase in the property tax rate in community one has the following effects: Labor flows from community one to community two; land is shifted from housing to wood production in community one while land-use is unchanged in community two; housing and wood production increase in community two while housing production falls in community one; the wage and housing price increase while land rent decreases in community one; the wage decreases while the housing price and land rent increase in community 2; the utility level of workers and community-one landowners falls while the utility level of community-two landowners increases. These conclusions are summarized in Table 1. By continuity, the comparative static results for this example also apply when τ_1 and τ_2 are "small" and equal.

It is easy to see that since L_1 falls and ℓ_1^K increases, the marginal products of labor and land in wood production in community one respectively rise and fall, causing the wage and land rent to rise and fall respectively.

Since ℓ_2^H is constant, the labor inflow to community two increases the marginal product of land in wood production and depresses the marginal product of labor, causing the wage and land rent to fall and rise respectively.

Recall that the general solution with identical tax increases in the communities lacked an unambiguous conclusion about the utility change for workers. The worker utility change for this case is easily derived in the above example, however, when $\tau_1 = \tau_2 = 0$, and the result is that worker utility falls when both tax rates increase. Recall that landowners are also hurt in this case.

IV.

The unavoidably arbitrary nature of any detailed model of the economy means that the results in this paper cannot be taken as definitive. Slight changes in the representation of the economy could lead to quite different conclusions about the effects of a property tax increase. Accordingly, the contribution of this paper should be viewed as primarily methodological. The most significant improvement over previous studies is our use of an explicit general equilibrium model for the analysis. In addition, we impose the appropriate long-run condition of equal utilities across communities for mobile workers, and realistically model the property tax as an *ad valorem* tax on housing services. Finally, the analysis incorporates demand effects, which have generally been ignored in tax incidence studies.

A goal for future research should be the development of other detailed models which further our understanding of the property tax. The attractiveness of the new view results should not make us believe that there is nothing left to learn in this important area.

Table 1

<u>Effects of an Increase in Community One's Property Tax Rate-Cobb-Douglas Example</u>

Prices

p_1	p_2	w_1	w_2	r_1	r_2
+	+	+	−	−	+

Inputs

ℓ_1^H	ℓ_2^H	ℓ_1^K	ℓ_2^K	L_1	L_2	K_1^H	K_2^H
−	0	+	0	−	+	−	+

Outputs

H_1	H_2	K_1	K_2
−	+	?	+

Utilities

workers	landowners in 1	landowners in 2
−	−	+

Footnotes

[1]For readable summaries of the new view, see Aaron (1975) and McClure (1975) and (1977).

[2]See Courant and Break (1974).

[3]Note that it was not necessary to specify the number of landowners in each community or the distribution of land among them at any point in the analysis.

References

Aaron, H. J., 1975, Who pays the property tax: A new view (Brookings Institution, Washington, D.C.).

Ballentine, J. G. and I. Eris, 1975, On the general equilibrium analysis of tax incidence, Journal of Political Economy 83, 633-644.

Break, G. F., 1974, The incidence and economic effects of taxation, in: The Economics of Public Finance (Brookings Institution, Washington, D.C.), 119-240.

Courant, P., 1977, A general equilibrium model of heterogeneous local property taxes, Journal of Public Economics 8, 313-328.

Harberger, A. C., 1962, The incidence of the corporation income tax, Journal of Political Economy 70, 215-240.

McClure, C. E., 1975, General equilibrium incidence analysis; The Harberger model after ten years, Journal of Public Economics 4, 125-161.

McClure, C. E., 1977, The new view of the property tax: A caveat, National Tax Journal 30, 69-76.

Mieszkowski, P., 1972, The property tax: An excise tax or a profits tax? Journal of Public Economics 1, 73-96.

M/D/165